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PURPLE NUTSEDGE (*CYPERUS ROTUNDUS*) CONTROL WITH DRIP-APPLIED METAM POTASSIUM

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Abstract. **Over the years, recommendations on metam potassium (K-Pam®) rates and efficacy have been inconsistent. Many of these inconsistencies are due to the lack of knowledge about application techniques. Therefore, multiple field trials were conducted to determine: a) the effect of K-Pam water delivery volume on weed control, and b) the influence of K-Pam concentration on nutsedge (*Cyperus rotundus* L.) control. In the K-Pam and water volume trial, treatments were the untreated control, and six combinations of two K-Pam concentrations (3,000 and 6,000 ppm) and three water flow rates (28, 43, and 57 mL min^{-1} m^{-1} per row). The application rate was 570 L ha^{-1}. Results showed that all K-Pam treatments effectively controlled purple nutsedge, regardless of the flow rate or the concentration. In the K-Pam concentration plus rate study, treatments were the non-fumigated control, K-Pam at 285, 570 or 1,040 L ha^{-1} applied at 3,000 ppm, and K-Pam at 570, 1,040, and 2,080 L ha^{-1} applied as 6,000 ppm. Regardless of the rate and total water volume, applying 6,000 ppm was more effective on nutsedge than 3,000 ppm. Finally, in the K-Pam concentration study, a fixed rate of 570 L ha^{-1} was applied in concentrations of 1,000, 2,000, 3,000, 4,000, 5,000, and 6,000 ppm. Results indicated that at 10 weeks after treatment, nutsedge densities declined linearly as concentration increased (y = 290.57-0.0409x), and that K-Pam concentration was more important than water delivery volume.**

The search for methyl bromide (MBr) alternatives has been a vast source of research during the last decade, in which hundreds of trials have been conducted statewide to examine different combinations of soil fumigants in polyethylene-mulched tomato (*Lycopersicon esculentum* Mill.), pepper (*Capsicum annuum* L.), strawberry (*Fragaria* × *ananassa* Duch.), cucurbits, cut flowers, and other commodities. Although, a great deal of progress has been achieved in this field, currently there is no single molecule to replace MBr. Instead, on-going research focuses not only on certain fumigant and herbicide active ingredients, but also on application techniques and formulations to improve efficacy (Duerksen, 2002).

Among the weeds, most of the attention has focused on nutsedge. Both purple (*Cyperus rotundus*) and yellow nutsedge (*C. esculentus*) have the ability to emerge through the mulch films and cause yield and quality losses. A great deal of research has been conducted with tomato, where some important alternatives are available (Noling and Gilreath, 2001). However, for other vegetables and ornamentals, these alternatives do not look as clear as for tomato. Examples of these are the methyl isothiocyanate generators dazomet, metam sodium, and metam potassium (K-Pam®; AMVAC Chemical Corp., Los Angeles, Calif.). The first two molecules have been the subject of extensive scrutiny with mixed results on nutsedge control (Ajwa et al., 2003; Locascio et al., 1997). Recently, various reports have suggested improved K-Pam performance on these weeds (Vaculin et al., 2003). However, K-Pam rates, application techniques and formulations are blamed for the inconsistent results. Because of this situation, field research was conducted to determine a) the effect of K-Pam water delivery volume on weed control, and b) the influence of K-Pam concentration on nutsedge control.

Materials and Methods

Water application volume and flow. Research plots were established at the University of Florida Gulf Coast Research and Education Center (GCREC) in Bradenton during Fall 2002 and Spring 2003. The soil was an Eau Gallie fine sand (Alfic Haplaquods, sandy, siliceous, hyperthermic) with 1.0% organic matter and pH 7.3. Selected fields were heavily infested

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by purple nutsedge (≈150 plants per m^2). For these trials, 0.20 m-tall by 0.80 m-wide beds were pressed and covered with low-density polyethylene mulch. Two drip irrigation lines (T-Tape Systems®, San Diego, Calif.) were buried in the bed center under the mulch film at a 2.5 cm depth. Irrigation emitter spacing was 0.30 m. Besides drip irrigation, continuous subsurface irrigation maintained the water table at 45 cm deep in order to reduce water stress.

A single K-Pam rate of 570 L ha^{-1} was injected with 100 (≈3,000 ppm) and 200 m^3 (≈1,500 ppm) of water. The water flow rates were 28, 43, and 57 mL min^{-1} m^{-1} of row within each water volume. An untreated control was included. These treatments were arranged in a randomized complete block design with five replications. Purple nutsedge was counted at 2, 10, and 15 weeks after treatment (WAT). Because of lack of normality and homogeneity of variances, purple nutsedge ranked means were analyzed with the Friedman nonparametric test ($P = 0.05$). Individual and grouped treatment means were compared with single-degree of freedom orthogonal contrasts ($P = 0.05$) (SAS, 2000).

Application rates. Field trials at the GCREC were carried out during Fall 2003 and Spring 2004 in similar fashion as described above. Water application rates were: a) 285 L ha^{-1} applied with 50 m^3 of water (≈3,000 ppm); b) 570 L ha^{-1} applied with 50 m^3 of water (≈6,000 ppm); c) 570 L ha^{-1} applied with 100 m^3 of water (≈3,000 ppm); d) 1,040 L ha^{-1} applied with 100 m^3 of water (≈6,000 ppm); e) 1,040 L ha^{-1} applied with 200 m^3 of water (≈3,000 ppm); and f) 2,080 L ha^{-1} applied with 200 m^3 of water (≈6,000 ppm). These treatments were arranged in a randomized complete block design with five replications. Purple nutsedge was counted at 4 and 10 WAT. This variable was analyzed with the same statistical procedure described previously.

Concentration levels. The effect of K-Pam concentration on purple nutsedge growth was assessed in Fall 2003 and Spring 2004 with similar methodology as explained above. The applied K-Pam concentrations were 0, 2,000, 3,000, 4,000, 5,000, and 6,000 ppm. Purple nutsedge densities were determined at 4, 6, and 10 WAT. The responses of the weed to K-Pam concentrations was characterized with regression analysis and individual means were examined with single-degree of freedom orthogonal contrasts ($P = 0.05$) (SAS, 2000).

Results and Discussion

Water application volume and flow. At 2 WAT, the application of K-Pam caused significant changes in purple nutsedge density, reducing weed populations to an average of 36 plants per m^2 in the K-Pam treatments from 144 plants per m^2 in the untreated control (Table 1). However, this effect disappeared at 10 WAT and beyond. There were no differences in purple nutsedge density among water flow levels and volumes, indicating that the speed of K-Pam injection did not improve efficacy. This finding suggested that K-Pam rates and concentrations should be studied more closely to improve purple nutsedge control, since K-Pam rate and concentrations of 570 L ha^{-1} and 300 ppm, respectively, failed to provide season-long purple nutsedge control.

Application rates. At both 4 and 15 WAT, all the K-Pam treatments improved purple nutsedge control with respect to the untreated plots, with weed populations being 5 and 2.5 times higher in the control than in the K-Pam treatments (Table 2). At all times, there was more weed control efficacy as K-Pam concentration increased from 3,000 to 6,000 ppm, regardless of the rate or water delivery volume used. Individual comparisons among water volumes rendered no significant purple nutsedge densities. Therefore, these results confirmed that water delivery volume alone was not an important factor to improve efficacy. Instead, water volume and K-Pam rate combined played a significant role in the definition of the concentrations applied in the field.

Concentration levels. Three regression equations characterized the response of purple nutsedge densities to K-Pam concentrations (Fig. 1). For 4 and 6 WAT, two logistic equations ($\ln(y) = 115.96 - 0.0004x$ for 4 WAT and $\ln(y) = 225.16 - 0.0003x$ for 6 WAT) represented the weed control trends. However, at 10 WAT a linear equation ($y = 290.57 - 0.0409x$) fit the purple nutsedge density response.

When individual points were compared with orthogonal contrasts, the application of 2,000 ppm K-Pam caused a sharp

Table 1. Influence of water volumes and drip line flow levels on purple nutsedge (*Cyperus rotundus*) densities at 2, 10, and 15 weeks after treatment (WAT) with metam potassium (K-Pam).

Fumigant	Water flow	Water volume	Purple nutsedge density 2 WAT	10 WAT	15 WAT
	(ml/min/m)	(m^3)		(plants per m^2)	
Control	—	—	144	248	623
K-Pam	28	100	27	260	526
K-Pam	43	100	27	397	611
K-Pam	57	100	51	327	661
K-Pam	28	200	48	348	533
K-Pam	43	200	24	243	445
K-Pam	57	200	36	264	575
Single degree-of-freedom orthogonal contrasts[1]					
Control vs. K-Pam			*	NS	NS
K-Pam 100 vs. 200 m^3			NS	NS	NS
K-Pam 28 vs. 43 ml/min/m			NS	NS	NS
K-Pam 28 vs. 57 ml/min/m			NS	NS	NS
K-Pam 43 vs. 57 ml/min/m			NS	NS	NS

[1]* = Significant effect ($P < 0.05$); NS = non-significant effect.

Table 2. Effect of metam potassium (K-Pam) rates and water application volumes on purple nutsedge (*Cyperus rotundus*) control at 4 and 10 weeks after treatment (WAT).

Fumigant	Rate	Water volume	Concentration	Purple nutsedge density 4 WAT	Purple nutsedge density 15 WAT
	(L/ha)	(m^3)	(ppm)	(plants per m^2)	
Control	—	—	—	45	200
K-Pam	285	100	3,000	8	149
K-Pam	570	100	6,000	1	67
K-Pam	570	100	3,000	2	143
K-Pam	1040	200	6,000	1	38
K-Pam	1040	200	3,000	2	64
K-Pam	2080	200	6,000	<1	21
Single degree-of-freedom orthogonal contrasts[1]					
Control vs. K-Pam				*	*
3,000 vs. 6,000 ppm				*	*
570 L/ha 6,000 ppm vs. 570 L/ha 3,000 ppm				NS	NS
1,040 L/ha 6,000 ppm vs. 1,040 L/ha 3,000 ppm				NS	NS
50 vs. 100 m^3				NS	NS
50 vs. 200 m^3				NS	NS
100 vs. 200 m^3				NS	NS

[1]* = Significant effect ($P < 0.05$); NS = non-significant effect.

decrease in the weed population, followed by slow density reductions thereafter (Fig. 1). At 4, 6 or 10 WAT, there were no differences in efficacy between 5,000 and 6,000 ppm K-Pam.

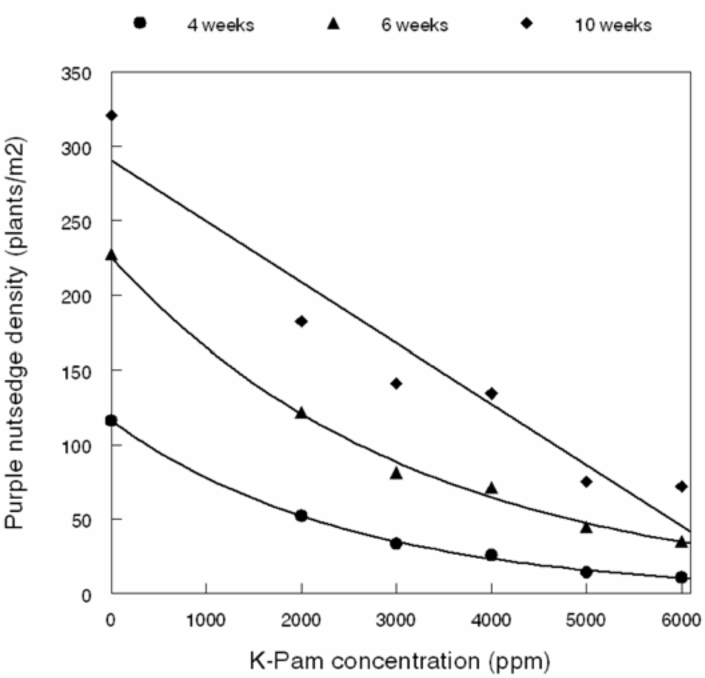

Fig. 1. Effect of metam potassium (K-Pam) concentrations on purple nutsedge (*Cyperus rotundus*) densities at 4, 6, and 10 weeks after treatment. Regression equations are $\ln(y) = 115.96 - 0.0004x$ for 4 weeks; $\ln(y) = 225.16 - 0.0003x$ for 6 weeks; and $y = 290.57 - 0.0409x$ for 10 weeks after treatment.

This indicated that 5,000 ppm appeared to be the critical K-Pam concentration to obtain nutsedge densities below 100 plants per 10 ft row (≈1 m^2). The application of 3,000 ppm had poor performance in the trials. This concentration has been usually recommended based on 60 gal K-Pam per acre applied with 1 acre-inch of water. These trials consistently show that concentration is more important that rates for effective nutsedge control with K-Pam.

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